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The American Foundrymen's Association is not responsible for any statement or opinion that may be advanced by any contributor to this Journal.

PROCEEDINGS OF THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Philadelphia Foundrymen's Association was held at the Manufacturers' Club, in Philadelphia, October 4, the president, P. D. Wanner, of the Reading Foundry Company, Reading, Pa., occupying the chair.

The Executive Committee, in their report, stated that a movement had been made by the Pittsburgh and Chicago associations toward having the papers presented at the meetings of all local associations, with reports of the discussions, turned in to the American Foundrymen's Association for publication in the journal of that association. The report also stated that it had been suggested that the initiation fees and dues now collected be adjusted so that the members of the association may become membres of all the associations. This step, adopted by associations at present existing, it was said, would be very helpful to foundrymen all over the country.

No action was taken on the suggestions contained in the report.

The Juniata Furnace & Foundry Company, Juniata, Pa., were elected to membership in the association.

The nomination of officers of the association, to serve during the ensuing year, was, upon motion, deferred to the November meeting, the election to take place also at that meeting.

The greater portion of the evening was taken up by the reading of the paper presented at the Pittsburgh convention of the American Foundrymen's Association in May last, by A. W. Walker, of the Walker & Pratt Mfg. Co., Watertown, and Boston, Mass., entitled "An Up-to-Date Stove Foundry." Mr. Walker was present, and showed 120 lantern slides in connection with the paper. There was no discussion.

PROCEEDINGS OF THE PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The Pittsburg Foundrymen's Association held its annual meeting Monday night, October 23, at regular headquarters, Frohsinn Hall, Pittsburg. The gentlemen placed in nomination by the committee at the last meeting were elected, as follows: President, Dr. Richard Moldenke, of the Pennsylvania Malleable Co.; vice-president, S. D. Sleeth, superintendent of the Westinghouse Air Brake Co.'s plant; treasurer, Phillips Mathes, of the Brittan & Mathes Co.; secretary, F. H. Zimmers, of the Union Foundry & Machine Co.; executive committee, I. W. Frank, Wm. Yagle, Robert Taylor, B. D. Fuller and E. A. Kebler. After the election some time was spent in chatting, and the members and visitors sat down to a luncheon, which was much enjoyed. The fifty guests present entertained each other with stories which are especially appreciated by foundrymen, many of them being told from personal experience, and a very enjoyable time was had. Dr. Richard Moldenke acted as toastmaster, assisted by Mr. F. H. Zimmers, and both gentlemen entered very heartily into the spirit of the occasion.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

IRON AGE.

Commenting upon the activity in foundry building, this journal says in its issue of October 12:

One of the specially notable features of the existing industrial activity is the number of foundries, large and small, now being erected throughout the West. This activity was first observed in the malleable trade. The demand in this line taxed the facilities of foundries two years since, and from that time the rapid enlargement of old works and the erection of new ones could not altogether keep pace with the increase in the demand for malleable castings. Capacity for production is still short, although it is expected that enough large new works will shortly be in operation to supply the necessities of the trade.

The gray iron foundries were by no means so hard pressed until this year, and it took a great increase in business to start into activity the idle plants then to be found in almost every manufacturing community. It appears that nearly everything of this character has at last been drawn into service, but the demand for castings has continued to grow, and much difficulty has latterly been experienced by manufacturers who purchase cast parts from jobbing shops.

The delay and inconvenience thus caused have led numerous manufacturing establishments to add foundries to their equipment. This is probably being done to a greater extent than ever before. Manufacturers who had never contemplated making their own castings, because they had always been able to get prompt deliveries of whatever they wanted and at reasonable if not very attractive prices, have actually been driven into the foundry business. At the same time the enlarged demand for finished cast iron products, as stoves, for instance, has caused foundries making such specialties to add to their molding floors. Some establishments in this line are now making the second en-

largement of their foundry departments within a year. The close of 1899 will see the foundry capacity of this country greatly enlarged. If all the foundries then equipped for work can be kept fully employed the consumption of foundry iron next year will show a heavy increase.

ENGINEERING MAGAZINE.

In the October issue of this journal Mr. Archer Brown, of Rogers, Brown & Co., has an article entitled "The revival in the Iron Trade; Will it Last?" from which we have taken the following:

"Going back now to the question, 'Will it last?' Frankly, it must be admitted no man knows. It is not given to mortals to unlock the future. War, famine, pestilence, Bryanism may intervene and upset all calculations. But the wise man faces the facts as they are before him, and builds his judgment on these, discarding optimism, pessimism, preconceived theories, and even tradition. There were never better settled or apparently sounder commercial traditions in the past than that dollar wheat, ten cent cotton and ten-dollar pig iron (at Birmingham) marked the bottom limits in the great staples; but we became familiar with values scarcely more than half these, and men lived and prospered.

"The simplest and largest fact in the present situation is a demand greater than the supply. What makes the demand? What limits the supply? The demand is great because seventy millions of people have pinched and economized for six or eight years, and now are quite able to buy, and, what is of more consequence, are in a mood to buy. They have made the old stove answer, worn out the harvester and threshing machine, postponed the building of the county bridge, got along with the old stationary engine or lathe, put off the purchase of needed rolling stock for the railroad, hesitated to try conclusions with England in the building of ships, and generally have waited for the return of what is known as 'good times.' Now they want to replenish, from the sad-iron to the locomotive. Will they stop because prices advance? No, they will not. Here enters the element

of human nature. Confidence breeds confidence. Distrust feeds on itself. Two years ago the great railroads of the United States could have renewed much needed equipment at about half the cost that to-day they do not hesitate to pay. Did they do it? It is notorious that the richest hesitated most. An amusing illustration is the case of a master mechanic of a great road whose requisitions underwent the usual cutting in two in the middle when they reached the management. Among the track and shop supplies needed was a large belt for an engine. When it came it had suffered the usual pruning, and was just half long enough to reach. The writer will not soon forget an effort, in the summer of 1897, to find a buyer in New York for 100,000 tons of Alabama pig iron which a large interest was willing to close out at $6 a gross ton, duly stored in a warrant yard——a price unprecedented in the history of the world. Not one of the great banking houses or capitalists dared face the perils connected with such a proposition, though money was ruling at 3 per cent. and nearly free storage on the material was guaranteed. To-day almost any bank in New York would lend $15 a ton on it, and scarcely ask a question.

"Buying, therefore, will not stop because prices are up. The railroads must have enormous additions to equipment, or lose the great harvest of profitable traffic. The millions of farmers will buy their agricultural machinery, stoves, carriages and pianos, because crops have been good for three years, fetch good prices, the mortgages are paid off, and there is money in bank. Electrical equipment will not stop while street railways and lighting companies make large earnings, merely because dynamos and rails are dearer. Cities and towns will put in needed water and gas pipe without much regard to whether the cost is $18 or $28 a ton. It is perfectly true that some new enterprises, that otherwise would take shape, are deferred because cost is found to exceed engineer's estimates. But this builds a reserve demand that will come in to support the market in the future. In high steel buildings, in large cities, for example, there is a distinct limit to prices that may be paid for materials without bringing the

cost to a point beyond earning ability. The merchant marine cannot be built up as rapidly from American shipyards on $28 steel as on $16 steel. But these are but eddies in the main current.

"The real factor in lowering prices will be in increased production, not diminished demand. How fast can the output of the furnaces be increased? I say not over 15 to 18 per cent. per annum. There was incredulity in as high quarters as Mr. Swank, secretary of the American Iron and Steel Association, when this prediction was made early in the year. For were there not a couple of hundred idle blast furnaces in the country ready to blow in the moment profitable prices were reached? Would American capital or energy hesitate where the reward was so great?

"It may be profitable to analyze the factors which operate to restrict profitable production. In a situation like the present they are clearly revealed, and many fine theories are upset by common physical facts. Few people who have not actually run a blast furnace realize what it means to fill the capacious maw of one of those monsters with raw material. A stack of 200 tons daily capacity, running on 50 per cent. ore, must have delivered to it each day something more than 400 tons of ore, 250 to 300 tons of coke, according to the character of the metal required, and over 100 tons of limestone, besides sand, coal and minor supplies —say 900 tons raw materials. Add the 200 tons of pig iron product shipped out, and we have a daily freight movement of 1,100 tons, taking no note of the disposition of the slag. This is 55 carloads of 20 tons each. The mining of the ore requires the labor of 150 to 300 men, according to location; the coal mining, coke making, quarrying of limestone and transportation at least 300 more. The furnace itself employs about 150 or more hands. It will be seen, therefore, that starting up a furnace of ordinary capacity calls immediately for the labor, from first to last, of nearly a thousand men; for the use of at least a thousand railway cars and many locomotives; for perhaps several steamers and vessels on the lakes; for capital, from the mines to the pig iron, of one to two millions of dollars, and last, but not least, for a high order of managing ability, the scarcest of all scarce com-

modities, in times like these. The easy theory, therefore, that production can be turned on, as from a faucet, when profits are high, does not fit the facts. It is needless to say that every nerve will be strained to get into operation at the earliest moment the few existing idle plants, but those who base their calculations on an increase of not over 12 to 15 per cent. per annum in the next two or three years will not go far astray.

"It has not escaped notice that in all the present excitement little is heard of organizing companies to build new plants. Each of the great consolidations is planning additions to capacity, but there are few schemes to develop idle property, as was the case about 1890. There are reasons for this. The building of furnaces to sell town lots was generally disastrous. The impression is still abroad that there is a large reserve idle capacity. But the main factor in restraint is that, under present conditions, it would require at least a year and a half to build a good modern plant; the cost would be 50 per cent. greater than a year ago—and who knows where iron would be when the furnace was ready to start? The wisdom of the policy of building and enlarging in bad times, followed for many years by Krupp and Carnegie, is demonstrated in a period like this.

"What of the export trade? It is generally believed that this new factor is the all-important one in sustaining American markets. Taking the iron and steel manufacturers as a whole, I believe this to be true. But so far as ores, pig iron and even steel billets are concerned, the movement has never reached 5 per cent. of the product of the United States, and probably will not for years to come. Radical changes in the freight and labor situations must occur before America can capture English and European markets with crude iron. She is shipping liberally, it is true, and will continue to ship, for prices in Europe will always be regulated pretty closely by those in the United States.

"But it is in the finished forms where American victories will be won, as they are now being won. In locomotives, wood and iron-working machinery, agricultural machinery, nails, wire, bicycles and a hundred other lines American inventive genius, great

productive capacity, modernized plants, superior business organization, etc., will maintain and doubtless increase the great total of $80,000,000 reached last year in her iron and steel exports. The effect of this great and growing foreign demand is sensibly felt in every department of the trade.

"The belief is widespread that exports from the United States must suffer a sharp check, if not come to a full stop, unless prices in America recede. This is a natural, but not well grounded, view. It assumes that the markets of the rest of the world go their way, irrespective of what the United States does. That was formerly the case, but it is so no longer. The world is now knit closely together in its industrial and commercial as well as its financial fabric. Influences that affect one nation are soon felt by the others. England and Germany were in the midst of industrial prosperity two years before it was felt in America, but now that she has responded, the added stimulus is felt over there. We think it phenomenal that the mills and furnaces throughout the United States should have their product booked half through next year, but in Germany and Belgium they are already booked all through the year 1900. The great Krupp works at Essen, employing thirty thousand men, are filled with orders until 1901. Germany has nearly overtaken Great Britain in pig iron product, but is nevertheless importing largely from both England and America to supply her deficiency. Great Britain shows a slackening in her shipbuilding industry, but her export trade in iron is again growing and all her lesser industries are exceedingly active. Prices of iron and steel have risen there almost as rapidly as in the United States. Middlesboro pig that sold last year for 43 shillings has reached 75 shillings and is now a little under 70 shillings.

"The fact is, the great industrial awakening is world-wide. China, India, South Africa, the Philippines, Japan, Russia and the new island possessions nearer to the United States are full of projects for improvement. They have caught the renaissance spirit. The beginnings are small, but they suggest immense future possibilities. They want steam railways, electric lines,

electric lighting, water works, locomotives, machinery, bridges, etc., and it scarcely seems probable that, having felt some of the benefits of modern progress, they will decide to turn back. America has shown her ability to compete with the other industrial nations for this trade, and will continue to get it in increasing quantity.

"A word as to the new level of prices. It is too high, of course, to be permanently maintained. It is too high for the lasting good of this great industry. But we must not be misled by making false comparisons. The conditions reached in the lean years following the panic were abnormal, not natural. Iron was forced to $6 a ton at Birmingham on wages of 90 cents a day for twelve hours work; on transportation rates that did not return the railroads' cost, and on destruction of royalties, or values of the ore and coal in the ground. The same was practically true in the Lake Superior district. It was simply a struggle for life. Values of great properties shrunk from millions to hundreds of thousands. Labor and capital fled to other fields. America learned great and valuable lessons during this trying experience, among others, how to produce iron more cheaply than has ever been done in the history of the world. Perhaps in the end the experience may prove to have been a blessing. But we must not make the error of supposing that those were normal conditions, and that when we have escaped from them we are on an artificial basis. A sound view is that we are nearer normal conditions to-day than we were when 100,000 tons of $6 pig iron went begging for a buyer in New York. A cent a pound for the best pig iron in the world should not, after all, paralyze the faculties of reasonable persons.

"It should not be forgotten that the cost of iron resolves itself substantially into three things—labor, transportation and royalties, or the value of the material in the ground. Labor, the largest item, is up 25 to 40 per cent. in iron making. It is not yet too high for the good of the country. Transportation is up about as much, but who shall say the stockholders of the railroads and steamship lines are not entitled to a few dividends after years of

waiting? It is now possible to credit ore and coal mines with something for the materials in the ground. But it is a violent assumption that the great iron and coal deposits of the United States, which are usually counted the foundation of wealth in an industrial nation, are actually worth something and should return a profit to their owners on material mined out? If these points are conceded, the legitimate cost of pig iron in the United States is at least 33 per cent. above the low level to which it was forced in the years from 1895 to 1898. The manufacturer's profit, if any, must be added to this. It is some satisfaction to know also that cost is rising proportionately in other parts of the world. In Great Britain and Germany the increase varies frm $2 to $4 per ton, according to kind of metal and locality where it is made. This is due mainly to the steady rise in the price of coke, although ores have advanced and are in short supply.

"Cautious investors as well as manufacturers quite naturally look forward to the time when collapse will again take the place of boom, and prices will drop below cost of production. Who shall stand against that day? The strong, who expect to survive, are taking etraordinary measures to equip themselves for whatever may happen. The huge consolidations—at least, thase newly organized—are free from bonded debts, with large provisions for working capital. Some of them, indeed, are lenders of money in the street. Nearly all have strengthened themselves by ownership of ore mines, coal mines, coke ovens and even transportation lines, so that they are independent 'from the ground up.' If the time ever again comes for a fight for existence, it will be between giants indeed, and no other nation can resist American inroads. But every observing man has noted, in the instructive years of the past decade, the wonderful tenacity of life of small plants well located and economically managed. Another thing that has not escaped notice is that in the 'survival' struggle, there is a marked tendency to equalize conditions in all the different districts. It is a fact capable of demonstration that the best returns on capital during the lean years were not from the great concerns in the most favored locations (barring one or two ex-

ceptions), but from certain smaller operators located in districts not usually spoken of as the cheap centers of production. It is a safe assumption, therefore, that, whatever lengths the consoldiation movement may extend to, there will be plenty of strong undertakings on the outside that will keep the industry on the sound footing of free competition."

IRON TRADE REVIEW.

In the issue of October 26 "Furnaceman" contributes an article on the "Problems of Heat Treatment," which we herewith reproduce:

The increasing appreciation of heat conditions has been the means of clearing away the confusion of doubts and surmises, which have for many years attached themselves to all casting operations. Heat and its equivalents which are embodied in pig metal are the nucleus of all possibilities contained therein. The caloric condition of blast furnace determines the grade of the product, and it matters not how carefully a theory for the burden may have been worked out, if the temperatures vary the calculation will be destroyed, for the metal will be influenced according to the amount of heat present.

There are many causes for an irregular working in stack, and the composition of burden is one of the least, for when fuel and atmospheric conditions are favorable, it is just as possible to produce a rich iron from a lean burden as it is from a rich one. After the iron has been cast, the conditions existing in blast furnace during casting will be reproduced in the metal and will be represented by the presence of several metalloids which are unquestionably dependent upon such conditions, for their appearance in the certain percentages which from an analytical standpoint determines one grade from another.

Therefore, the chemical composition and grading fracture is again the direct consequence of heat manipulation. The heat of furnace when iron is tapped will be shown in the percentages of silicon and graphitic carbon present in the metal. A No. 1 iron with a high silicon and graphitic carbon content, will be a

"hot" metal, and the No. 5, with low silicon and carbon, will be a "cold" iron, and there is no deviation from this rule irrespective of variance in practice.

The No. 1 iron may be remelted and refined at a lower temperature and be hotter, retaining fluidity longer than the No. 5 iron, which requires a higher temperature to melt, and when taken away from heat influence loses its fluidity and chills at once. Silicon and graphitic carbon are always present in ratio. The amount of graphite present is entirely dependent upon the percentage of silicon. It would be quite impossible in regular working, to have an iron with four per cent of silicon, and no graphitic carbon, and the reverse, four per cent graphite and no silicon.

Curiously enough, sulphur is also the product of heat working; it has, however, no bearing upon the fluidity of metal when remelted. The No. 1 or "hot" iron will contain but very little of it, while the No. 5 or "cold" iron, will have considerable, as this latter iron when passing the fusion zone in stack is very dull, and being spongy is an absorbent of impurities in fuel and slag. The evil effects of sulphur are very prominent when iron has been refined, and when worked under the hammer or rolls, we meet with the familiar "red-shortness."

Phosphorus appears to be the only metalloid which through all the variable conditions of furnace, manages to retain in a measure some proportion of its original calculation in burden. Its direct influence on metal being remelted is in turn also dependent upon the amount of heat which the metal is capable of developing. In gray iron and malleable casting it serves as a factor for fluidity. But in all grades of steel it is debarred on account of its well-known characteristic "cold-shortness."

Manganese has not, as a general rule, been as prominent in pig iron calculations as the other metalloids. Of late years the percentage has been gradually increased, hoping thereby to derive some benefit from its ability to slag off sulphur and its supposed effects upon the combination of carbon. Manganese has not, however, been recognized as a leading factor. It would appear that with careful consideration of heat conditions and their

important bearing upon the chemical constitution of iron, we could derive some very beneficial knowledge which would have its bearing upon the physical status of the metal. This would have more reference to the iron casting industries than steel, for in the instance of the latter no matter what may have been the original heat conditions, all the latter are eliminated and there is substituted for the original contained factors, the highest degree of artificial heat possible.

Therefore leaving steel out of the question for the moment, iron casting, and particularly malleable will be considered. Malleable is produced in many ways, some entirely out of the beaten course. Yet the material has always been maintained at a very uniform quality. It may be reasoned that underlying all furnace operations there has been an influence at work, which has not always been recognized, and was possibly this same heat theory. When a heat is made up for the malleable furnace the chemical and physical limits are almost always calculated by the analysis and grading. These figures vary in individual works, but are firmly established in local practices. After the heat is charged the first opportunity for heat treatment is presented, for here the chemical and physical make-up will be altered. Iron in air furnace is capable of resisting, without burning, an amount of heat, somewhat in excess of that which prevailed during first casting at blast furnace. The fluidity and heat of the metal will be governed by the average grading of mixture. Most important to be guarded against is overheating the metal—exposing it to the chance for burning. There are several things which warn the watchful of this contingency and when noted are of service. When the charge is high in silicon, and there is difficulty encountered in combining carbon after the metal is hot enough to pour, continued blast cannot but burn the oxide of iron. When the mixture is in this condition, there has been an excess of silicon, and in heats following the grade should be altered to overcome this trouble. Burnt iron is worthless, for the oxide has been past its limit, and when this iron comes through the annealing oven there is no mistaking its history. Burnt iron may also be detected by the brown smoke

from ladles showing thus clearly the volatilization of the oxide. The heat of the blast and furnace, in connection with the chemical complexion of the metal, plays the deciding part in casting details, etc.

The action of flame influence upon mixtures for heavy and light work is at once prominent, on account of its being directed toward the accomplishment of the same end, through different channels. In the instance of heavy work, the mixture being low in silicon, and possibly high in combined carbon, the flame from the beginning of heat will be exerting an oxidizing influence driving the small percentage of graphitic carbon into combination, and while the heat is "coming up," will further a higher state of combination. In a light work mixture with high silicon and graphitic carbon the flame, after bringing the iron to the melting point, will have to burn out some of the silicon, before the carbon will enter into combination. And here more than at any point in furnace heat practice, should the metal be given great attention. Too often will the metal be burnt at this moment, having lost, as it were, some of its factor for defense. A heat should never be exposed to a flame that is beyond the resisting powers of the mixture. In other words, when the furnace is too hot, instead of a natural evolution being formulated in the metal, the silicon and carbon content is simply burnt out by this intense heat, the oxide being impaired at the same moment. This latter action is similar to that in the Bessemer converter; for when heat rises, after the passing of the silicon, the iron thus exposed is quickly scorched.

The action of the flame upon the metalloids has its bearing also upon physical standards. Again taking the mixtures for light and heavy work, it will be found that the physical results are governed greatly by the percentages of certain metalloids in the mixtures. Heats for both classes of work may be made up of the same irons, in different proportions, to meet any specification required. A mixture high in silicon will offer, from the theory of the volatilization of a certain part of its silicon, an opportunity for the flame to "catch" the iron, while a heat lower in silicon repels any other action of the flame, other than that

which liquifies the metal. Regarding the strength of these mixtures the high silicon-carbon cannot develop the tensile figures of the low silicon-carbon because the former will be an open metal, while the latter will be very dense. The lower the percentages of silicon and carbon that may be maintained for all classes of work, the higher will be the tensile strength and elongation. High tensile cannot be obtained from high silicon, for the latter has a disintegrating influence upon the metal in annealing.

Silicon which stands as the exponent of a contained heat factor cannot be overestimated as to its work in facilitating the passage of graphitic carbon; but after the metal has been poured into molds, its presence is deleterious, for it makes possible, by reason of its known heat containing qualities, the renewal of graphitic carbon. A heat for any special class of work should be so calculated and arranged that the silicon figure should not be higher than that which will allow the carbon to turn over, without the holding of metal in contact with flame to accomplish this purpose.

The conversion of the carbon in a malleable furnace should be worked on as nearly a chemical calculation as is possible, coupling theory with practice. Artificial heat will eventually overcome any deficiency in calculation, but a natural evolution is brought about by the iron being carefully adjusted. This is essentially heat condition. All iron from the blast furnace is either gray or white, depending upon the action of hot gases upon the ores for the percentage of carbon present. The blast furnace theory of heat treatment is that the gases of combustion ascending through the furnace leave quantities of their positive elements to combine with the oxygen of the ores, that is carbonic oxide leaves carbon. This carbonic oxide absorbs the oxygen from the ores, and leaves the protoxide; the ore in dropping to the hearth will be composed of metallic iron and foreign matter. If this process is not well performed, and this of course is directly consequent upon the degree of heat generated, some oxide of iron will be left in the slags, to be eventually flushed off. Any ore which being thus treated, without its surplus of

carbon from the gases, cannot produce anything but white iron. All the carbon for making gray pig metal must be in the ore before it sinks to the hearth. Therefore with a hot furnace and hot blast we assume a surplus of free carbon in gas mixtures, which carbon, if it is not chemically, is at least mechanically mixed with the gas, and being very finely diffiused, eventually penetrates into the ore.

The heat and pressure of the blast have almost the controlling influence in the blast furnace, and also the air furnace. The pressure of blast is the one factor which creates a heat condition. In blast furnace practice we find that the carbonic oxide liberated by the fuel unites with the ores, and afterwards enters into the composition of the metal. In air furnace practice we find the same gas liberated under dissimilar circumstances, and acting in a strictly adverse manner. If we thoroughly understood the character of pig metal, we could regulate for various mixtures some approximate pressure of blast required. The regular and constant pressure with which the blast enters the air furnace, no matter what may be the character of the iron, may account in a measure for many apparent irregularities in furnace operation and quality of metal when cast. For the remelting and refining of pig iron, regarding the pressure of blast, etc., there must be in the air furnace a condition the reverse of that which occurred in the blast furnace during the smelting. For example, if the mixture is made up of gray iron, which was produced under high thermic condition, a soft blast is preferable, because this iron contains a high degree of heat efficiency itself, and with a high pressure the danger of burning is greatly enhanced. If the mixture be composed of white irons originally created under low furnace heat there will be required to melt them a high pressure blast for the substitution by artificial means, of a quality they do not possess.

Perfect combustion of air in reverberatory furnaces has much to do with the physical character of the metal, and it is of course consequent upon the heat generated in the fire hole. Imperfect firing means volumes of air passing through the furnace unburnt. It was to correct this last defect, that the blast was in-

troduced over fire bridge walls. The heat of a combustion flame contains the amount of oxygen necessary to nourish the chemical and mechanical reactions taking place in the furnace. That flame influence in the furnace should be positive is a very important point, for if by any chance the combination of the metalloids is not thoroughly effected, there will be trouble all along the line. Carbon must be in combination at the moment of pouring. If it is not, it will keep the iron porous, and oxygen in the anneal having access to the interior of the castings, will cause a reaction to ensue resembling decomposition. Carbon does not combine at low temperature in the air furnace and the heat of the blast must be carefully regulated after the combination has been made. In the heat for heavy work, when the iron will average a No. 5, with its small percentage of silicon already oxidized, the carbon being also in combination, the blast will have to raise by its means, an artificial heat condition. If the metal in the air furnace were kept exposed to the flame long enough, the high temperature would eventually cause the combustion of carbon and steel would be the result. When pig iron is deprived of its carbon, its cohesion and ductility are increased, but if the amount of silicon is disproportionate to that of carbon the iron is beyond improvement and to offset this latter contingency, the addition of re-carburetting metal is made to steel before leaving the furnace.

The flame treatment should be given all care, in order to overcome, to the extent possible furnace losses. Much depends upon the quality of iron composing the charge, and this in turn depends upon blast furnace operation. Good soft gray iron or white iron generally furnishes metal of unfailing quality. Charcoal iron has always, on account of the absence of foreign matter, yielded more iron, ton per ton, than coke metal, the furnace loss with the latter often reaching 15 per cent of the entire charge. It is a serious problem to suggest any method to prevent this great loss of metal. The general consideration of heat treatment and conditions will, it is believed, be of great service to the metallurgist, for it will acquaint him more intimately with the latent capabilities in the metal, and thus, coupled with an-

alyses, will give him the history of the iron beginning at the blast furnace.

THE TRADESMAN.

To a number of questions referring to the grading of pig iron, its chill and other features, Mr. E. H. Putnam replies:

Pig iron is graded either by the appearance of the fracture or by chemical analysis. You can tell the grade of iron either by chemical analysis or by close application in practical iron founding and in studying the fracture of the pigs for a period extending over, say, a dozen years, more or less. That is to say, a good deal of experience is needed in order to judge accurately by fracture, and even then you will sometimes get left. It will help you greatly if you test the product daily by breaking test bars, keeping a record of the breaking strain and the shrinkage, bearing in mind that the harder the iron the more it will shrink.

Cast iron is chilled by casting it in contact with solid iron. That portion of the iron which comes in contact with the "chill," or solid iron which forms a part of the mold surface, is thereby rapidly cooled, and becomes solidified before the carbon (which is always chemically combined in molten iron) has time to segregate out from the iron and assume the graphitic state.

A chilled fracture may be recognized by the peculiar appearance of the crystallization. It always looks as if the grain of the iron were perpendicular to the chilled surface, and it is so.

No iron is chilled except that which has been cast against solid metal. Bear in mind right here that all iron will not chill. Charcoal iron that has a strong chilling tendency should always be employed in the mixture. Scrap steel may be used instead of the charcoal iron, but I do not advise it.

No. 7 iron is of white fracture, not because it has been cast against a chill (for it has not been so cast), but because the carbon is chemically combined with the iron.

Among the foundry irons, probably No. 2 is produced in greatest quantity.

Each cast from the blast furnace is of practically uniform grade.

No. 5 chilling charcoal iron is pretty near right for making chilled plow "wings," or mold boards, of ½-inch thickness. But I advise you to use instead a mixture of Nos. 4 and 6. By this method you will be able to make it a little harder or the reverse, as required.

A chilled mold board must be chilled clear through everywhere; but the iron must not be hard enough to a much greater depth or thickness or the casting will be weak.

The share must have a chilled edge and a gray body. The landside must be chilled at the "heel" but nowhere else.

The same writer, dwelling upon some features connected with the manufacture of malleable iron, says:

A great deal of light has been shed upon this branch of metallurgy during the last few years. So dazzling was the light at times that the uninitiated were apt to be blinded and mystified by its excess. My policy, during the several years that I have conducted this department of The Tradesman, has been to instruct in those things that I knew to be true, and so, to be as helpful to the reader as possible; also to warn our readers against following the lead of writers on foundry practice where expenses without commensurate benefit would ensue, and where sometimes only disaster would result. It will be remembered that for a period of a year or more just prior to the revival in business, when pig iron of all kinds was selling at a very low figure and makers were trying every possible scheme to get business, a strong argument was put forth by some writers to exploit coke iron as the equal of charcoal iron for chilled goods; and that I persistently combatted this and insisted that the maker of high grade chilled castings must use charcoal iron in the mixture. A pretty extensive acquaintance with actual practice in many different parts of the country and a knowledge of practically all that has been written on foundry practice in both England and America for some years past fortified me very strongly in my position. When a man publishes an article claiming that he is making first-class chilled castings from all coke iron, and you visit his foundry and find him using charcoal iron in the mixture,

you are apt to wonder either why he wrote as he did, or why he doesn't practice what he preaches.

There has been going the rounds of the trade journals press a good deal of literature concerning the manufacture of malleable iron that is calculated to mislead foundrymen who are not familiar with the business. Not that the writers have intended to mislead. It is rather a case of erroneous judgment in this instance. I am here referring to the claim often made during the last two years, that in order to succeed in the manufacture of malleable iron it is highly important that a chemist be employed at the plant, among whose duties should be that of analyzing the irons to be used. Now, I have never denied that, in some foundries, it would be expedient to employ a chemist and have been much inclined to concede the general application of the argument in relation to the making of malleables. But, a visit to a number of important malleable iron manufactories, without finding a chemist at a single one of them, rather knocks the underpinning from the argument for the chemist even in this line of founding. It has always seemed to me, and I have always said, that the place for the chemist is at the blast furnace, where the iron is made. When I go to the drug store and ask for a quart of silicate of soda, I get a quart of silicate of soda; I know it, not by making a chemical analysis, but because I have the (implied) assurance of a chemist who is employed at the manufactory that it is silicate of soda. It is now pretty generally the same way, and will soon be universally so, in the case of pig iron. Nevertheless, at the present time, there are many large manufactories engaged in lines of product where the employment of a chemist is, no doubt, a measure of economy, and insures a more satisfactory product than could otherwise be gotten. But this concession does not apply to general founding. In short, if you are engaged in the manufacture of agricultural machinery and wish to make your own malleable you can do so with perfect success, without employing a chemist. What you want is simply a manager who is thoroughly posted in the manufacture of malleable iron. He will select his mixtures from the analysis furnished

by the blast furnace chemist, and he will make you as good malleable as you are buying to-day.

But do not go into the manufacture of malleable iron unless you use at least 300 tons of castings a year. And even with this tonnage of consumption it is a question as to whether it might not be more economical in the long run to buy the castings. If, however, the intention were to expand into a large business the fact that you are able to use a few hundred tons per year in your own work would constitute a condition greatly in your favor.

The wonderful growth of the malleable iron industry of recent years marks it as a business that should engage the attention of founders in all sections where the conditions are favorable to its prosecution. There is absolutely no secret connected with its manufacture. It is a simple process, perfectly easy—if you know how! Anybody can buy the iron from the blast furnaces, such as malleable iron makers use; mix this so that when melted and hot enough to pour, it will produce a casting in which all the carbon is combined with the iron; that is, so that the fracture will be white. Pack the castings with rusted rolling mill scale (oxidized by treatment with solution of sal ammoniac) in hard iron pots, and, placing them in the annealing oven, maintain a degree of heat the color of light orange for a period of four or five days, and if the heat has been pretty uniform throughout the oven your product will be all right. However, though the processes are simple and easy of practice when once you become familiar with them, yet it would be a great and expensive mistake to undertake the business without the assistance of a number of men thoroughly experienced in the business. The things that, above all others, the manager ought to know all about, are: (1) Pattern making and gating; (2) founding; (3) annealing; leaving analytical chemistry entirely out of the category, relying on the blast furnaace analysis.

If you are going to produce for your own use solely, and your castings are to be on the light order, or if you do not require the highest grade of castings as regards strength and ductility, the cupola will answer very well for the melting, and it is more economical for a limited product, and more easily and

cheaply managed. But if you are going to manufacture for the general market you had better start out with the reverberatory furnace at once, else you will have to refuse many of the best paying jobs, as the cupola product would be unsatisfactory.

THE FOUNDRY.

Wm. Roxburgh, writing of porosity and shrinkage of brass castings, says:

Position of casting has a great deal more to do with the successful production of castings than many imagine. More than a decade ago I had to do with the casting of some heavy brass chunks weighing about 1,000 pounds, say about 4′ by 2′ by 3½″ thick with a few oval cores interspersed of the usual bolt hole order, and as these castings had to withstand an extraordinary tensile strain, it was resolved to cast them in the vertical position, as by doing so it was considered that solidification would be more complete and that an improved metal for tensile resistance would be secured, but alas for vertical casting, it was a complete failure. After three successive attempts the vertical position had to be abandoned and not until those castings were cast on the flat or horizontally did success attend our efforts.

In casting these chunks in the vertical position, the top end had two gates not less than 3″ square and about 18″ apart, one being used as a pouring gate and the other as a riser. We were careful to use good hot metal and also to employ the feeding rod. We had hot metal standing by in a crucible to replace that lost by shrinkage, yet notwithstanding these precautions, feeding these castings solid had become an impossibility and usually ended with the rods being caught and held fast in the gates, the top end of the casting being a group of cavities of all sizes.

Very reluctantly the person in charge assented to change the position of casting to the horizontal. This, I held from the first to be the most favorable on account of brass having so much greater tendency to "draw" than iron. In this position the depth of the mold was only 4″ as against 48″ when casting vertically. Those figures being exclusive of flask and risers, which may roughly be reckoned as the same in either case. Hence it is

obvious that the pressure is 12 times greater at the bottom of the vertical mold than of the horizontal. This will show the greater compression of the former method.

The details of casting these chunks in the horizontal position were as follows: The mold was placed on a level and six pouring gates judiciously distributed so that every part would be filled at one and the same time; the gates were about 1-¾″ in diameter and with a pouring basin large enough to admit of the ladle being almost instaneously emptied. One or more risers were placed to assist in relieving the strain. No feeding was necessary with this arrangement, the method of gating being sufficient to feed the casting automatically.

R. H. Palmer contributes an article illustrating the molding of a jacketed cylinder head.

In "Cast Iron Notes," W. J. Keep writes of the shortage of pig iron and its influence upon the quality of castings as follows:

During the period of depression pig iron was cheap and the founder could get exactly the kind he asked for. The furnace had plenty of time to grade iron and was careful to ship the grade called for because it could not afford to stand any rebate on account of off grade. During all of this time the advocates of analysis made but little impression by their arguments, because with plenty of first-class stock the founder could feel reasonably certain of the good quality of his castings.

The founder made so little money that he took but a small interest in any kind of improvement.

Now all has changed, but the change has brought new complications. The founder has not been able to advance prices to keep pace with the advance in the price of pig iron and of labor, therefore his profit is not at all satisfactory. It would be more correct to say that this was so during the first part of the year, for at present each founder has more work than he can do and has to a large extent completed contracts taken at lower prices, and has advanced his prices so that profits are satisfactory. But now a problem of a very serious nature meets him. He cannot get the kind of pig iron he needs and can get but a limited quantity of any kind. It is only by tracers and all kinds of hustling

that he can get iron enough to keep running, and quite often the small founder is obliged to borrow a car or a few wagon loads of iron to prevent the loss of a heat.

Worse than all this, he has to borrow what he can get and when he returns a like amount the lender has to take what is returned, whether it is the same as borrowed or not.

There is a scarcity of soft irons all over the country. Railroads are not able to deliver cars as wanted and founders find that they have irons that are too hard one day, but hardly ever enough soft iron. The rush of business and anxiety to fill orders with a profit, and the question of getting any pig iron at all takes all of the founder's time.

Now is the time he needs analysis. If he could have a card containing the analysis of each car, or could know the amount of silicon that it contained, he would have a guide as to its quality, but unfortunately the furnaces are shipping the iron as fast as made and a card showing the analysis would in many cases show that the iron was totally unfit for the purpose it was to be used for, and for this reason the analysis is not furnished. The founder has no other iron and can get no other and must use this. He has no softener much of the time. He uses all the scrap he can get and the furnace wants all blame laid to the scrap or to other pig iron that was used along with theirs. There is no time for the founder to have a chemical analysis made of each car he receives.

These conditions drive him to the only other method to test the quality, viz.:, the measure of shrinkage of a test bar. It is a fact, that if the shrinkage does not vary, the quality does not vary, whatever kind of pig iron or scrap is used. If the shrinkage does vary the quality also varies, and the variation of shrinkage shows what will bring the quality back to the standard. If the shrinkage is more than is desirable an increase of silicon will reduce shrinkage and bring the quality of the castings back to the standard.

If the founder is compelled to use irons that are not to his liking the measure of shrinkage gives the quality of those irons.

A few days ago I was asked by telephone by a founder in a

neighboring city how he could use all scrap for a few days, and how he could know whether his castings were injured, for he could not get any pig iron for a week, but had plenty of scrap in his yard. I told him that the only way to know whether he could do so was to compare the shrinkage of these castings with his usual mixture so as to have a satisfactory standard. The change in shrinkage afterwards would tell him how much scrap he could use. The present conditions make it necessary to keep a record of quality so as to be prepared for just such emergencies.

A few weeks ago Mr. Brundage, superintendent of The Gale Manufacturing Co., of Albion, Mich., told me that he had used the shrinkage test for the past three years, and had a record of the shrinkage and strength of his iron for each day, and could tell by the numbers on the machines sold exactly the quality of iron in each, and that this had stopped all complaints regarding his castings. He said that the plan had worked to perfection.

Then there is another reason why a founder should know exactly the quality of the iron that goes into his castings, and that is if the shrinkage is right he will know that his iron is right and will look to other causes for defects. Lately I have had a number of castings sent to me with request for an opinion as to how to vary silicon to prevent the defects. In one case it was blowholes, and was due to mixing too much steel scrap in the ladle. The trouble was not with the mixture at all, but with the method. By charging the steel scrap in the cupola along with the iron the blowholes did not appear. In another case the trouble was scabbing, and was not due to graphitic deposits from too much silicon, but from too dense a sand and insufficient venting. In another case shrinkage spots were caused by improperly proportioned patterns. By reducing the size at that point or by coring out a portion of the iron at an enlarged part the defect could be remedied. In all of these cases it was supposed that chemical analysis would show that there was too little or too much silicon. If they had known that the quality of the iron was right they would have looked for a remedy in some other direction. A record of quality should be kept each day

so that no one would think for a moment of blaming the iron. With the right kind of iron the percentage of good castings will be increased very largely. Watch your return overmelt and you will find it very much smaller if your iron is hot and fluid right along. It is better to use a little more coke if by doing so you can get a greater percentage of good castings. Don't look for something mysterious whenever anything goes wrong. The way to prevent this is to test the quality of your iron each day.

In an article on "Malleable Castings" the author, under the nom de plume of "Melter," says:

Forty years ago the term malleable iron was used with reference to an altogether different material from that of to-day. Then it was all sorts and conditions of wrought iron; now it applies to the castings industry almost entirely. Wrought iron is malleable in the strictest sense of the word, though castings are more so, for in reality the scope of a casting is not as limited as that of a bar of iron, hence its ready adaption to large territory not open to ordinary wrought iron, and thus the term has passed.

When we look back at the early methods employed in malleable casting, and make a comparison with modern practice, we must place the credit to the melters and metallurgists, who have solved the theoretical reactions and applied such knowledge to melting. The air furnace has undergone practically no change whatever, but the methods used for selecting the proper irons are radically different. Wrought, or malleable iron as it was called then, to be of good quality was silvery white and fibrous, and the malleable of to-day was thus an experiment, and every heat was liable to develop something the preceding heat did not. To-day a malleable casting of good quality will show a velvety black fracture, with silvery "glints" here and there. How many men have endeavored to produce castings with some sort of fibre? And how many have tried to cast wrought iron into green sand, hoping to thereby avoid the tedious annealing operation? It was quite alluring, and many wiseheads were turned by the experiment; and still, some believe it possible. Whether it will be accomplished or not depends upon the

younger element, as the older men have already had their fling at it. There has been a considerable amount in print of late concerning the theory and practice in vogue at malleable plants, and from a very close observance of the same one can make the assertion that each individual plant is operated upon its own independent method. That is, of course, if we believe all that we read. With some men there is nothing comparable with carbon for good results, others place all confidence in silicon, and following these are the devotees of phosphorus and manganese. Sulphur seems to be left out in the cold, but hold, in semi-steel it has its innings. We never used to hear all this wrangle about the composition of the metal; if it was good, and showed a clear, black fracture, the specifications seemed fulfilled. But to-day we have a critical market to face, both buying and selling, and a well-posted commercial public to satisfy. We buy everything on analysis, but do not sell so, and trust malleable cast iron will never become as scientific a quantity as that. There is no gainsaying the fact, however, that the melting operation has been given a very close attention during the last ten years, and both the old style grading and the new style of chemical calculations are given all the importance possible with direct practice. Quoting a very recent print in "The Foundry," these sentiments are expressed, referring to cupola practice, but directly applicable to malleable as well, viz: "Much of the so-called new light on cupola practice that has been published has been theoretical, and untold troubles have arisen by managements trying to imitate what nobody had actually accomplished!" There is, great truth in this, and to be conservative one must be competent to discriminate against untried suggestions. Let the others experiment! But just to keep in touch, the writer offers these expressions, asking consideration of those who know as to whether his surmises concerning theory and practice are in keeping with other opinions, upon the effects of the metalloids found in pig iron.

Years ago carbon was the one great factor; there was nothing to be compared with it, and iron was selected with especial reference to the amount present, or rather, the appearance of

amounts present, for we were without chemical analysis then, and we charged the darker irons with the grading of a No. 1 and No. 2! Silicon, which to-day is easily recognized, was then subordinate. Looking backward, with the aid of latter-day research by chemistry, we can readily understand the long hours required to melt small and large heats. There was with this high carbon a high silicon content, and it was an impossibility to effect the chemical re-actions any faster. But, is the metal of to-day superior to that of the earlier melts? Long time in furnace, a soft blast, and at the end a natural and easy combination of the elements produced some mighty fine iron. When comparison is made by the production of a 10-ton heat in four hours, having its metalloids carefully adjusted, and rushed along at high pressure, the original practice is out of it. But again, has the metal benefited in proportion? There is one thing, however, of which we are learning more every day, and which was not spoken of then, namely the recognition of heat conditions all through production. It stands for all that is practical and theoretical. The formations of structure in pig iron and castings, the certain percentages of metalloids in the pig, the time consumed in refining iron in reverberatory furnaces, are all contingent and consequent upon the variations of temperature! When arranging a heat to-day, the melter has an advantage not previously enjoyed, of knowing why a heat of iron will be hotter, and retain its heat longer, than a companion heat composed of No. 5 iron and sprues. In the No. 1 irons are large proportions of silicon, that metalloid, which stands for heat conditions, and in the No. 5 irons, silicon is at a minimum, hence the dullness of irons with that grading. Blast furnace people explain these differences by saying that a No. 1 iron is produced only when the stack is working very hot, and No. 5 when the furnace is chilling. Hence the presence or absence of silicon is purely a heat condition! When this knowledge is applied to malleable refining, it is naturally a great advantage.

The aim in malleable is to produce a metal which will "set" quickly in the molds, and return its carbon in combination. Often when metal is too hot, the carbon will return to the graphitic

condition, because there is enough heat in metal to allow it the chance to disseminate. This is one of the first stumbling blocks met with in melting, and the cause is too often laid to carbon, while in reality there has been too much silicon present. The percentage of total carbon does not change greatly with the grading, but silicon is never constant, varying in every change of grade, in fact making such gradations possible and necessary. If the early melters recognized heat conditions, they never applied the same to their operations. Theory and reality have rescued modern melters in this instance. When a heat is charged of No. 1 iron the metal will be liquid and hot enough to tap in a few hours, but we must wait until a physical reaction has taken place in the metal, namely, the combining of the carbon, and this will not occur until the silicon has been reduced enough to withdraw sufficient heat from the metal to insure stability of combined carbon in the castings. This is not only theory, but actual consequence.

There are two metalloids which will aid in combining carbon, manganese and sulphur, the action of the first is beneficial to the metal, though uncertain, while the latter's effect is certain and highly disastrous.

Singularly enough sulphur is another product of a heat condition. When blast furnace is working very hot it is at a minimum, but with a reversal of conditions it is maximum, for in the latter case the iron, like a sponge, is ready to absorb, and sulphur is thereby taken up from the fuel. Thus in "high" coke irons, with a large percentage of combined carbon, we have also considerable sulphur to contend against. Phosphorous has already been of great aid to the foundryman in iron casting. In gray iron it is counted a great factor for fluidity, and the same holds true in a measure regarding malleable, though not with such directness, on account of its actions being restricted regarding scope. If, as in gray iron, there are large percentages of carbon and silicon present, it will unite its action with theirs, but if the heat should be made up of No. 5 irons there would be no opportunity for its action on account of the dullness of these high irons.

Phosphorous, like other metalloids, has its harmful effects. Even in small quantities it has an influence upon the malleability and strength of iron at ordinary temperatures and causes "cold shortness" that is a tendency to break "short" off when cold. Manganese has of late attracted something more than a passing attention, for the metallurgists are taking advantage of the knowledge that its condition in iron as a sesquioxide has a bearing upon the certain combination of carbon, and also when in large percentages its ability to act as a flux. There has been only one objection to it, and that is, when used in proportions which might suggest an excess, the annealing requires more time, as the carbon has been combined higher than is usual. The effect upon the physical status is beneficial, for the tensile strength of metal high in manganese is above the average. Castings which will be satisfactory to consumers must, above all things, be of a uniform quality, and to insure this feature too much attention cannot be given the details of melting and annealing. There are many times in the hurry of business when the melter has to be absent, and at such moments accidents sometimes occur we would rather not mention.

Information and literature on this subject should be accessible to all who may comprehend, and it is for the general welfare of the art that this is urged. The annealing operation, so the metallurgists tell us, is a process of cementation, actuated by the liberation of carbonic oxide gas in furnaces, furthered by preparing the packing in sal-ammoniac, or by using ore high in oxygen. That the carbon in castings is eliminated when high temperatures have been reached in furnace by the combination of this gas with the carbon of the castings.

Of course, primarily speaking, there is nothing which will anneal iron but heat. There are many works who do not prepare the packing in any manner whatever, yet the annealing goes on, and carbon is eliminated. This may appear as negative, but it is true. To the average reader may occur the thought that malleable men are working behind a mass of theoretical deductions, having no bearing on what is a very simple process, but those who are familiar with the operation and the

difficulties there encountered are very ready to adopt any theoretical reasoning which may be helpful to them.

To those who know malleable iron, it is not a simple process. And those who do not thoroughly understand the principles there involved have some disagreeable experiences with it. It is in the light of further knowledge that we all hope more will be written of this metal. But, as before quoted, those who have suggestions which have never seen actual practice had better keep same to their own selves.